Crop Protocol
Root Crops
carrots, leeks, sweet potato

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Why grow in raised beds with drip irrigation?

Drip Irrigation: A network of drip irrigation pipes and tapes with small holes , brings the irrigation water directly to the plants. This has the following benefits:

- The grower is able to apply only what is needed by the plant, avoiding the wastage of water associated with flood and overhead irrigation systems.
- Water is more uniform to all plants, reducing the loss of yield due to uneven watering (too much as well as too little).
- The leaves, flowers and fruit of the crop plant is not wet due to over head irrigation, which can reduce the risk of folair and fruit diseases, that need free water to develop spread.
- The drip irrigation system, reduces the need for labour to fetch and carry water to the crop, allowing time to be used more productively (weeding, training the crop etc).
- Liquid fertilisers can be applied using the drip irrigation system.

Raised Beds: Planting crops on flat ground makes them more liable to water-logging if irrigation is uneven. It is helpful to plant on slightly raised beds, to assist with the drainage of water. There are other advantages to using raised beds:

- The number of pathways between rows of plants is reduced to make more profitable use of the soil for planting crops, whilst maintaining access for crop husbandry (weeding, spraying etc).

- The bed system makes it easier to organise a planting programme (the number of meter square of each crop planted each fortnight) and the rotation plan (alternation of legume, leafy and root crops).

Drip Irrigation system

Take advice from a qualified irrigation supplier on the design of a drip irrigation system. The following information is a guide to the factors which need to be considered.

Water source: For food production to be reliable all year around, the Nutrition Garden needs to budget on having sufficient water to grow the crops needed. Here are some calculations to assist in working out if the site has enough water to grow the crops needed: For example:

- An average crop covering one hectare (10,000 meter square) will use about 10 mm of irrigation per hectare per week (520 mm of irrigation per year).

- One millimetre of irrigation water per hectare is equal to 10,000 litres of water; therefore this would require 520,000 litres of water per year. One thousand litres of water is equal to one cubic meter of water.

- If the weekly budget for water use per hectare is at least 10,000 litres – this is equal to about 1,500 litres per day. Most of the Nutrition Garden pilot schemes are very small – about 20 beds, each 10 meters long (200 meter square). This is 2% of one hectare, therefore it will use 2% of the water budget (2% of 1,500 litres per day = 30 litres per day).

- Real Impact Nutrition Garden pilots have been supplied with a 1000 litre water storage tank – which is adequate for the water storage for 33 days irrigation (about one month).

- If the seasonal rainfall is about 200 mm in April/May and another 100 mm in November - this is a total contribution from rainfall of 300 mm of irrigation water. During the rainy season – it will not be necessary to apply as much irrigation water through the drip system.

- Assuming an average water requirement of 520 mm per hectare year - another 220 mm or 2,200,000 litres is needed (per hectare) from another source (river, borehole, Municipal Council) at other times of the year. This may have to be stored.

Water storage: To determine the water storage required, the grower needs to decide if water is available all year around. If so, very little water storage is needed.

However, if rainfall is an important source of irrigation water, the grower needs to harvest and store this water. Water can be harvested from the roof of buildings. The area of the roof for rain water harvesting needs to be measured to obtain the meter squared of water catchment.

- For every 1 mm of rain that falls on one hectare of land (10,000 m.sq), there will be 10,000 litres of rain water. Therefore for every 1,000 meter square of roof space (e.g. 25 meters wide x 40 meters long) for rainwater harvesting – for every 1 mm of rain fall on the roof, there is a potential harvest of 1,000 litres of water.

- If 200 mm of the rain comes in April/May this will potentially produce 200,000 litres of rainwater harvest, even from a small roof of only 1,000 meter square.

- If the 200 m sq. Nutrition Garden pilot needs only 30 litres of water per day – this is equivalent to less than 1,000 litres per month.

- If there are only 3 months of the year when rain is reliable; then there are nine months when stored water needs to be used. This is 9 months x 1,000 litres = 9,000 litres (9 cubic meters). The maximum water storage needed for the small Nutrition Garden pilot is 9,000 litres.

- If the Nutrition Garden pilot is expanded to half a hectare (5,000 m.sq), the average weekly water use is 5,000 litres per half hectare. Nine months of unreliable water supply would need (9 x 5000 litres) at least 45,000 litres of stored water (45 cubic meters).

Another factor which needs to be considered when calculating the amount of water storage needed, is the amount of evaporation of water from the surface of the water storage area. Water stored in a closed tank will not evaporate but water stored in an open dam will evaporate at different rates, depending on the amount of wind and sunshine. Windbreaks and floating covers will reduce this water loss.

Fig 1: Bag reservoir/header tank

Alternatively water can be stored in a closed bag system, and can also act as a header tank if elevated on a soil platform.

Drip irrigation lines: Three drip irrigation lines are used in the Nutrition Garden per raised bed. This allows up to six rows of plants to be planted per bed, depending on the crop grown.

Fig 2: three lines of drip for carrots (with mulch)

Small crops such as carrots, onions, spinach and leeks, will be planted in two rows of plants on either side of each of the drip lines (6 rows of plants per bed). Larger crops are planted at 2 rows of plants per bed (cabbage) or 4 rows per bed (sweet potato and French beans).

The distance between the holes in the drip irrigation line can be different. The Nutrition Garden drip lines have holes at 20 cm spacing.

When setting up a drip irrigation line the hole in the drip line should be facing upwards (to the sky). This makes it less likely for the hole to get blocked by sand in the irrigation water. The drip irrigation line is not buried in the soil – it lies on the soil surface in a straight line.

The end of the drip irrigation line is usually secured by bending it around a peg at the end of the bed. A short piece of drip irrigation tube can be cut off at the end and used as a sleeve to hold the end of the drip line in place.

Header Pipes: The drip irrigation lines are connected to a larger header pipe which runs along the top edge of all the beds. The beds run perpendicularly off the header pipe at a 90 degree angle.

Fig 3: Large Header Pipe brings water to drip lines

The slope of the land needs to be considered when deciding the direction of the beds to ensure even distribution of water. If the drip lines are incorrectly placed to follow the slope of the land from high to low (downhill) – then there will be a lot of water dripped at the bottom of the hill and not enough at the top of the hill. Plants will not grow well as they will be water-logged at the bottom of the hill and too dry at the top.

To avoid this, the header pipe should follow the slope from top to bottom and the drip irrigation pipes should run along beds which follow the contour of the land.

Header Tanks: The water needs to flow into the drip irrigation system under some pressure to ensure an even flow of water along the full length of the drip irrigation lines. The higher the header tank is above the main header pipe of the drip irrigation system – the higher the water pressure (measured in pounds per square inch) and the further the water will travel.

EQUIPMENT:

Connectors: These are a pair of plastic valves which screw onto the drip irrigation pipes to join two pieces together.

Gate valves: The header pipe needs to be connected to the main water source (water tank). There may be more than one header pipe in the system, depending on the complexity and the scale of the farming and layout of fields. A gate valve has a 'tap' which can switch on and off various header pipes where the beds do not need irrigating.

Fig 4: Gate valve (black centre tap)

End caps: All the header pipes need to have end caps – to prevent the water dripping out of the end of the pipe.

Water pump: The capacity of a pump to lift water from once source and pump it to another place is determined by its ***head*** and **flow rate**. The **head** is the maximum height to which a pump can pump water (specified on pump in meters or feet).
Sometimes the water **pressure** generated by the pump is measured in *psi* (pounds per square inch).

To convert from **head to psi**:

pressure (psi) = 0.434 * head (feet)
pressure (psi) = 0.132 * head (metres)

To convert from **psi to head**:

head (feet) = 2.31 * pressure (psi)
head (metres) = 0.705 * pressure (psi)

Before purchasing a pump, it is necessary to measure the height difference between the pump's water inlet, and the highest point the water is to be pumped. The **head** of the pump chosen must be greater than that measured distance, ideally by at least 25% so the pump is not over-worked.

The **flow rate** is a measure (typically in litres or gallons per minute) of the amount of water which can be pushed out of the pump. This flow rate falls when water must be pumped upwards - i.e. a pump with a head of 5 metres and a flow rate of 10 litres per minute, will have a flow rate of 0 litres per minute if the water is to be pumped 5 metres or higher.

For non-submersible pumps, a further measure is ***lift***. This tells you the maximum difference in height between the pump, and the end of the pipe connected to the pump inlet.

Suppliers

Mavuno Fertilisers
Email: merchant.mustafa@armafrica.com
Mobile: +254 - 0733 - 866020,+254 - 0722 - 493608
Website: www.armafrica.com

Hygrotech:
Email: sales@hygrotech.co.ke
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Irrico:
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Website: www.irricointernational.com/

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Why grow carrots, leeks and sweet potato?

Carrots: The flesh can be cooked as a vegetable, or dried and made into flour. The flour is very rich in vitamin A and can substitute some of the cereal based flour in breads, uji or ugali to increase the nutritional content and also enhance the flavour and colour of the food.

Fig 5: carrots

Even though this is not a common habit – the leaves of carrots can also be cooked as a leafy vegetable. Since a lot of leaf can be produced, this maximises the utilisation of the food produced by a carrot crop.

Carrots are easy to grow and are very rich in vitamin A, protein, iron and zinc. It is therefore very good for the immune system.

	Protein	Vit A	Vit C	Vit B6	Vit E	Iron	Calcium
carrots (fresh)	2	341	6	8	5	2	3
carrots (dehydrated)	16	1369	24	52	27	22	21

Table 1: % RDI from 100 grams of cooked carrot produce

Leeks: This crop is a suitable alternative to onions in many recipes and since the total yield per meter square is higher than that possible from onions (due to the harvest of the green leafy section), then the nutritional yield per meter square of garden is higher.

	Protein	Vit A	Vit C	Vit B6	Vit E	Iron	Calcium
leeks (fresh)	2	16	7	6	2	6	3
onions (fresh)	3	zero	9	6	zero	1	2

Table 2: % RDI from 100 grams of cooked leek/onion produce

Sweet potato: This is a commonly grown root vegetable in East Africa. It is easy to grow and can be grown on sloping ground as part of a soil erosion strategy. Sweet potato can be cooked as a root vegetable and the leaves can also be consumed as a leafy vegetable. The flesh can be dried and ground into a flour and used in baking and as a nutritional supplement in uji and ugali.

	Vit A	Vit B6	Vit C	Iron	Calcium
Sweet potato (fresh)	315	8	21	4	3
Sweet potato flour	30	3	28	3	2

Table 3: % RDI from 100 grams of cooked sweet potato produce

Planting Programme

Carrots, sweet potatoes and leeks are considered part of the Root Crops in the rotation plan and are grown after the leafy crops in the rotation (spinach and cabbage) and before the legume crop (French beans).

There are two Rotation Groups – one for crops that are only in the ground for about 12 weeks (fine beans, cabbage and carrots) and one for crops that are in the ground for about 20 weeks (2 crops of French beans, continuous cropping spinach and sweet potato).

Not all crops are needed in the canteen in equal quantities so the space for the root crop in the shorter rotation group is shared between carrot and leeks.

Rotation Group	weeks in ground	ROOT crop	ROOT crop planting interval	ROOT crop area planted	LEAFY crop	LEGUME crop
1	12	50% carrots 50% leeks	4 weeks	1.75 m.sq. (leeks) 0.75 m.sq. (carrots)	cabbage	1 crop of French Beans
2	20	sweet potato	2 weeks	5 m.sq	continuous harvest spinach	2 consecutive crops of French beans

Seek advice from your Real Impact Agronomist on the planting interval and the meter square to be planted each time.

A general guide for a small Nutrition Garden with 20 beds, each only 10 meters long, is to plant the areas in the table above, at the weekly intervals stated.

How to grow sweet potato

Crop Rotation

Sweet potatoes are in the *Convolulaceae* Family and should not be planted directly after other crops in the same Family.

However, there are very few commercial crops in the *Convulvulaceae* Family and issues in rotation rarely occur for this reason. Sweet potatoes should not be grown in the same place however, year after year.

Sweet potato is a '*root crop*' so it should be planted after a '*leafy crop*', which will have removed a lot of nitrogen from the soil. If too much nitrogen is in the soil when a root crop is planted, the yields of tubers tend to be lower. Examples of suitable l*eafy crops*, which could have been planted earlier in that piece of land, include:

- kales
- spinach
- broccoli
- cabbage
- Indigenous vegetables

Bed Preparation

- Sweet potato is grown on raised beds or mounds.
- Prepare a standard raised bed of 1.2m wide.
- Cultivate the ground to a depth of 40 cm.
- 3 rows will be planted per bed, so lay 3 drip lines equally spaced.

General Fertiliser Recommendations

Nitrogen and Phosphate

Excessive amounts of nitrogen will increase leaf formation as opposed to tuber formation in root crops Nitrogen fertilizers in small amounts (5 to 15kg N/ ha – or 2 grams of Nitrogen per meter square) are not harmful to root growth and can be beneficial by pushing out the early root growth to establish a stronger plant.

The above amount of nitrogen would be available from a DAP base dressing of about 20 grams per meter square.

DAP includes some phosphate, not only nitrogen. Since phosphate is not very mobile in the soil, it is best to apply this as a band fertiliser 3 – 4 inches deep and 3 inches away from the tuber or transplant. There would be sufficient phosphate in the above application rate of DAP, to commence growth of the root crop.

If the grower is an organic grower and does not wish to use DAP - add vermi-compost at 1 kg/m^2.

Foliar sprays-

- Vermi-liquid at 1:10 dilution – one 15 Litre knapsack per 100 meter square – every week.

Topdressing-

- Apply **80 g/m^2 of CAN** 25-30 days after planting.

Vermi-liquid (fertiliser)

It is possible to manufacture liquid fertiliser from waste vegetable matter and manure in shallow trays, using litter worms (like earthworms) to feed on the material to produce humus.

The humus is kept moist by carefully applying low amounts of water over the top of the tray, to keep it moist but never wet (this will drown the worms). The tray containing the litter worms is held at a 1% slope, so that the leachate drains to the end of the tray, escaping through gaps into a gutter and then into a collecting tank.

The vermi-liquid is very concentrated and should normally be sprayed onto crops, in a 1:10 dilution to avoid scorch.

Real Impact runs training courses in how to construct and manage a vermi-liquid unit and worms for starter packs can also be purchased; contact admin@realimpact.or.ke for details.

Vermi-liquid trays should be shaded to prevent the compost from drying out and the worms from dying.

Do not add manure or vermi-compost to the sweet potato beds as excessive fertilizer will inhibit root formation.

See separate brochure for technical details on vermi-composting and vermi-liquid production.

Planting sweet potato

Planting material*:* Sweet potatoes are propagated from vine cuttings about 30 cm long taken from the mature end of the vine (i.e. not the young tips of vines). Only take cuttings from healthy, plants with disease-free leaves, otherwise the new crop will not be healthy.

- The vines should be carefully harvested to avoid damaging the vines and placed in a clean bag for transportation. Keep the vines cool and plant as soon as possible to maintain the quality of the plants. Never store for more than one week.

- Carefully remove all the leaves from the vine (without damaging the stem) except for the leaves at the very tip of the piece of vine. Water is lost through transpiration from the leaves and such water loss may also dehydrate the stem. A good quality, turgid vine will produce more vigorous roots.

- Make sure that at least 2 leaves are left at the top of the piece of vine as these leaves will also contribute to the development of the new vine roots.

Planting method*:* New roots develop at the old leaf node joints of the cutting. Those nodes which are buried below the ground will probably develop into sweet potato tubers.

- The cuttings are 30 cm long. Plant 20 cm below the ground and allow the 10 cm with the leaves still intact to be above the ground.

- In the bed system, there will be three lines of drip irrigation tape. Plant 3 vines per meter of each of the tapes – giving 9 plants per meter square of bed.

- To avoid wilting of the vines after planting, do not rely on the drip irrigation system for the first 2 weeks. Irrigate manually using a watering can at a rate of 1 jerry can/m^2 every other day.

Harvesting*:*

- Sweet potatoes are ready for harvesting within 16-18 weeks after planting. They must be harvested at this time, so that the rotation and planting programme of the Nutrition Garden can be managed effectively.

- They are harvested by digging up the roots from the side of the ridge with a fork when the soil is moist to prevent damage to the roots. If left too long in the ground the roots can become oversized and unmarketable.

- Do not damage the skin when lifting the tubers from the ground. Allow them to air dry on the soil surface for a few days to toughen up the skin (cure).

Yields

Sweet potatoes can produce an average yield of 2-4 kg/m^2.

Storage

Without controlled temperature stores, it is not advisable to store fresh sweet potatoes for longer than 2 weeks. This is why a planting programme is used, so that a regular supply reduces the need for long term storage, since the quality is reduced after 2 weeks.

It is not possible to store them in the ground, if the bed system of planting is used, as the crop needs to be removed so that the next rotation crop is planted on time.

However, if a separate perennial area is set aside for sweet potato, then tubers can be harvested on an 'as required' basis, directly from the ground. There is a risk of weevil damage to such tubers and they may get overgrown and 'woody' if not harvested frequently.

SWEET POTATO PESTS

- Sweet potato weevil
- Sweet potato stem borer
- Wireworms
- Flea beetle
- Nematodes
- Sweet potato whitefly

SWEET POTATO DISEASES

- Scurf
- Black rots
- Sweet potato F*usarium* wilts

Pesticides are not generally needed in sweet potato production, if good quality vines are used. Remove caterpillars by hand if observed (use gloves).

How to grow carrots

Crop Rotation

Carrots belong to the family *Apiaceae* (*Umbelliferae)* and should not be either continuously planted in the same place or planted directly after other crops in the same family such as:

- parsnips
- celery
- parsley
- coriander

If poor rotation is practiced the carrots will begin to suffer from carrot pests and diseases, particularly nematodes.

Other crops not in the *Apiaceae* family, but which are still bad previous crops, (because they also suffer from similar pests) include:

- melon
- cucumber
- squash
- okra
- tobacco
- onion

Good rotation will alternate different *types* of crop as well as different *Families* of crops because different types of crop take away and put back different minerals from the soil. The ideal rotation of the *type* of crop is:

1. **Legume crops** (e.g. peas, beans peanuts **)**
2. **Leafy crops** (e.g. sukuma wiki/kales, cabbage, spinach etc)
3. **Root crops** (e.g. carrots, onions, carrot etc)

For rotation purposes, carrots are considered as a '*root crop'* therefore carrots should be planted after *leafy crops,* which will take excess nitrogen out of the soil. Examples of suitable crops, which could have been planted as 'previous crops' to carrots in that piece of land include:

- kales
- spinach
- broccoli
- cabbage
- indigenous vegetables

Bed Preparation

- Carrots are grown on raised beds - 1.2m wide.
- A fine soil texture is needed because the carrot seed is so small and to produce well-shaped, large roots.
- Cultivate the soil down to a depth of 20 cm.

Fertiliser Programme

Base dressing

- The base dressing must be applied before the seeds are planted.
- Use 100g DAP per m^2 - but split this into 6 lots and try to concentrate the applications near to the drip lines where the carrots will be planted later. This is because root crops need a lot of phosphate and this mineral is not very mobile in the soil, so it has to be placed near the crop – but not so close as to scorch the young roots.
- Rake the fertiliser into the soil after application.
- If the crop is an organic crop and cannot use DAP – use rock phosphate instead according to label instruction.
- Do not use too much nitrogen fertiliser or manure, as this will cause the crop to produce too much leaf and not enough root. It may also cause the roots to 'fork'.

Weekly foliar sprays

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- Vermi-liquid (10 x dilution)

Seed priming: Most vegetable seeds (except for pea and bean seeds) can be primed to germinate better, if they are soaked overnight in clean water. Do not soak them for longer than12 hours. Then drain them and spread them out on newspaper to air dry in the shade for a couple of hours. Plant immediately – using the guidelines below.

Sowing carrot seed: Carrot seed is very small. It needs to be weighed properly to avoid wasting it, especially when planting small areas every week. Care is needed to plant it at the correct depth, as it will not germinate if planted too deeply.

- 6 rows will be planted per bed, one row of either side of 3 drip lines equally spaced in the bed.
- When the carrots are mature there will be about 20 carrots per meter of drip line. If there are 6 rows of carrots in the bed – there will be 120 carrots per meter of bed.
- Assuming many of the young carrot seedlings will be thinned out, the grower should budget to apply three times this amount of seed per meter row of bed (360 seeds).
- There are between 400 and 1,200 carrot seeds per gram. Therefore the budget should be about one gram of seed per meter of bed planted.
- The average planting programme in the Nutrition Garden is 0.75 meters of carrot planted every 4 weeks. Since carrot seed is not expensive and is very small, it is best to budget on using one gram of seed per planting.

- One level teaspoon of seed is about 5 grams. So less that 20% of a teaspoon of carrot seed is enough for this planting programme.
- If the area to be planted is bigger than this, re-calculate the amount of seed needed.
- Carrot seeds are very small and difficult to distribute using only one gram of seed very evenly in six lines. To make this easier, mix the seed with half a jam jar full of fine dry sand. When it is thoroughly mixed, then 'dribble' in the carrot seed/sand mixture along the line of the six planting rows.
- Carrot seed must be planted into fine shallow lines made in the soil. Mark out six straight lines along the bed using a string and two sticks at each end to keep it straight. Then use a pointed stick to trace along the line of the string and make a very shallow line, into which the seed will be drilled. Do not plant more than one centimetre deep.
- Cover the seed with soil straight after planting and gently press the soil on top of the seed to ensure the seed is in good contact with the soil around it.

Mulching and Irrigation: Carrot seeds should be irrigated carefully by hand using a watering can with a fine spray nozzle on the end – do not rely on drip irrigation to get even germination of seeds. One watering can of water should be enough for three meters of beds with germinating carrot seeds.

Apply a thin layer of mulch to the top of the bed, after planting the seeds and before they have germinated. This will help to retain the soil moisture and encourage even germination. Use seed-free dry grass as mulch. Make sure there are no seeds in the mulch or they could also germinate and become weeds.

Thinning and weeding: Within 6 weeks, it is possible to carefully pull out extra seedlings to leave good strong carrot seedlings at about 5 cm spacing between carrots. These small carrots can be eaten and included in recipes for stews.

Harvesting: Carrots are mature within 12 weeks. Harvest carrots by grasping the foliage and pulling it out of the ground.

Yield: Carrot yields of up to 4-6 kg/m^2 can be achieved.

Fig 6: mature carrots

Post-harvest: Wash the carrots after harvesting. Bunch the carrots into groups of ten and tie together including the tops. Both the roots and the tops can be eaten.

Storage: Store carrots in a cool dry place (below 5° C but not at 0^0 C).

CARROT PESTS

Carrots in Kenya do not suffer from the globally common, carrot fly. However, nematodes can be a serious pest, and occasionally aphids cause problems

- nematodes
- aphids
- cut worm

Fig 7: root knot nematode (left) and cutworm (right)

CARROT DISEASES

There are no serious diseases of carrots in Kenya. In hot dry weather, powdery mildew may be a problem.

Fig 8: powdery mildew on carrot leaf

How to grow leeks (or onions)

Crop Rotation

Onions and leeks are in the family Amaryllidaceae and should not be either continuously planted in the same place or planted directly after other crops in the same family such as:

- garlic
- chives
- shallots

Onion is a root crop so it should be planted after a leafy crop which will have removed a lot of nitrogen from the soil. If too much nitrogen is in the soil when a root crop is planted, the yields tend to be lower. Examples of suitable leafy crops which could have been planted earlier in the same piece of land include:

- kales
- spinach
- broccoli
- cabbage
- indigenous vegetables
- Brussel sprouts
- cauliflower

Bed preparation and fertiliser programme: follow the guidelines for carrots.

Transplant production: Both leeks and onions can be grown either from seed sown in the ground (as for carrots) but establishment and yield is generally higher if transplants are made in seed trays and the crop established from transplants.

- It will take about 4 weeks to produce a transplant 5 cm tall – ready for transplanting.

- Sow 2 seeds per cell in the plant seed tray and use a deep seed tray at least 4 cm deep to produce a good quality root.

Fig 9: Onion transplants

- Reduce watering on the 3rd week & transplant on the 4th-5th week.
- Water 1hour before transplanting

Transplanting:

- 6 rows will be planted per bed, one row of either side of 3 drip lines equally spaced in the bed.
- When the leeks or onions are mature there will be about 20 bulbs or stems per meter of drip line. If there are 6 rows of crop in the bed – there will be 120 onions or leeks per meter of bed.
- Mark out the rows where they are to be planted – close to the drip lines (about 5 cm away).
- Make a deeper trench than that used for carrot seeds (about 4 cm deep and lay the transplants into the trench – evenly spaced at 15 cm between the transplants.
- Cover the transplants with soil to the same depth as they were in the seed tray. Press them in firmly and then irrigate well with a watering can.

Seed priming and direct seeding:

Onions and leeks can also be direct seeded into the soil, instead of transplanting.

- Soak seeds for 12 hours before planting.
- Make 1 cm deep drills and sow two seeds every 2 cm apart
- Cover lightly with soil and irrigate well with a watering can.
- Four weeks later, thin to 1 seedling per hole at a spacing of 5cm within a row.

Irrigation:

- Irrigate well and stop only at maturity and bulb ripening.

Harvesting:

Onions:

- Harvest commences 12-16 wks and 8-12 wks if started from seeds and transplants respectively.
- Onions are ready for harvesting when at least ½ the tops have fallen over and the bulbs' skins have a papery feel.
- Very gently coax the remaining leaves down, without breaking them off the bulb.
- Allow the bulbs to sit in the ground, cure for a couple of days and harvest by pulling them upwards.

Leeks:

- Harvest commences 12-16 wks and 8-12 wks if started from seeds and transplants respectively.
- Pull the leeks from the ground without damaging the roots, by firmly holding the green leaf and pulling it out.
- Both the green leaf and the white partition is used in cooking
- Wash the soil off the roots.

Yields: Yields of up to 3-4 kg/m^2 could be achieved if proper management practices are carried out.

Post-Harvest

Onions:

- Do more curing (expose onions to temps of 30-35^{0}C for 1-2 days).
- Cut the leaf from the bulb, leaving less than half a centimetre of the neck.
- Dry the bulb in the sun as often as possible to ensure the neck heals completely.

Leeks:

Treat the fresh leeks like a leafy vegetable and keep in fresh in a cool environment in the dark. Consume within one week.

Storage:

- Store cured onions in a place with low temperatures, high relative humidity and good airflow.

OR

- At room temperature in a loosely woven container, or open mesh container.

MAIN ONION and LEEK PESTS

- Onion thrip
- Leaf miners
- Onion flies

See other Crop Protocols for identification and control of these pests.

MAIN DISEASE of ONION and LEEKS

Downy mildew is a fungus which causes pale–green, yellowish to brownish areas of irregular size and shape (oval to cylindrical) on infected leaves or seed stalks.

The masses of spores are at first transparent to greyish, and then rapidly become violet in colour. Leaves become girdled in the region where mildew develops and the leaves collapse. This results in dead leaf tips.

Fig 9: Downy mildew

Other Diseases

Purple blotch, Fusarium basal rot, Onion rust, Bacterial soft rot and Neck rot.

Uwezo

Syngenta make a series of good quality, reliable pesticides in pack sizes suitable for small-scale farmers – the series is called UWEZO. Uwezo is stocked by most agrovets in Kenya. The pack sizes are sufficient to use in one 15 litre spray tank.

Check the Labels and use the product specific to the pest present. Do not spray if the pest levels are not high. Observe all health and safety instruction and leave the recommended number of days after spraying before picking any produce